EXHIBIT "A"

SERIAL NO.: 10/041,111

DOCKET: TUC920000094US1

Goodfellow

Polyethylene - U.H.M.W. (UHMW PE) - Material Information

Buy Polyethylene - U.H.M.W. online

Buy small quantities online of Polyethylene - U.H.M.W. for research and/or development

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Fabric Fiber Film Powder Rod Sheet

General Description:

Common Brand names : Hostalen GUR Stamylan UH

See also General Information under Polyethylene - Low Density

General Description : A semi-crystalline, whitish and effectively opaque engineering thermoplastic which, chemically, is a very high molecular weight (3-6 million) HDPE. As a result it has an extremely high (effectively infinite) melt viscosity and can only be processed by powder sintering methods. It also has outstanding toughness and cut and wear resistance and very good chemical resistance, somewhat better than that of HDPE.

Applications include many "wear parts" (eg bottle handling machine components), gears, bearings, artificial joints and marine quay headings. Fibers of very high molecular orientation can also be made from polyethylene of very high molecular weight by gel spinning and subsequent drawing to give fibers which are reported to be up to 85% crystalline and with 95% parallel orientation. They are known as Ultra High Modulus or High Performance Polyethylene fiber (UHMPE or HPPE). A modest range of fiber, braided cord and fabrics are avilable from Goodfellow.

Like Kevlar, these fibers have very high tensile properties and (small) negative CTE's. On a volume basis, their tensile properties are broadly similar to Kevlar's but, on a weight basis, they

are superior thanks to an almost 50% density advantage - but they are not up to the properties of carbon fiber on either basis. Their energy absorption and acoustic velocity characteristics are superior to Kevlar's both as fabric and composite. Applications are being developed particularly in the areas of ballistic protection and ropes (in the widest sense).

Chemical Resistance

Acids - concentrated	Good-Fair
Acids - dilute	Good
Alcohols	Good
Alkalis	Good
Aromatic hydrocarbons	Fair
Greases and Oils	Good-Fair
Halogenated Hydrocarbons	Fair-Poor
Halogens	Fair-Poor
Ketones	Good-Fair

Electrical Properties

Dielectric constant @1MHz	2.3
Dielectric strength (kV mm^{-1})	28
Dissipation factor @ 1MHz	1-10 x 10^{-4}
Surface resistivity (Ohm/sq)	10^{13}
Volume resistivity (Ohmcm)	10^{18}

Mechanical Properties

Coefficient of friction	0.1-0.2
Elongation at break (%)	500
Hardness - Rockwell	R50-70
Izod impact strength (J m^{-1})	>1000
Poisson's ratio	0.46
Tensile modulus (GPa)	0.2-1.2
Tensile strength (MPa)	20-40

Physical Properties

Density (g cm^{-3})	0.94
Flammability	HB

Limiting oxygen index (%)	17
Radiation resistance	Fair
Resistance to Ultra-violet	Poor
Water absorption - over 24 hours (%)	<0.01

Thermal Properties

Coefficient of thermal expansion ($x10^{-6}$ K^{-1})	130-200
Heat-deflection temperature - 0.45MPa (C)	69
Heat-deflection temperature - 1.8MPa (C)	42
Specific heat (J K^{-1} kg^{-1})	1900
Thermal conductivity @23C (W m^{-1} K^{-1})	0.42-0.51
Upper working temperature (C)	55-95

Properties for Polyethylene - U.H.M.W. Fiber

Property		**Value**		
Material		Dyneema®	Spectra A®	Spectra B®
Specific Modulus	cN/tex	9000	12500	17500
Specific Tenacity	cN/tex	265	265	310
Density	g cm^{-3}	0.97	0.97	0.97
Extension to break	%	3.5	3.5	2.7
Modulus	GPa	87	120	170
Shrinkage @100C	%	<1		
Tenacity	GPa	2.7	2.7	3.1
Thermal Conductivity @23C	W m^{-1} K^{-1}	20 (axial)		

Properties for Polyethylene - U.H.M.W. Chopped Fiber

Property		**Value**		
Material		Dyneema®	Spectra A®	Spectra B®
Specific Modulus	cN/tex	9000	12500	17500
Specific Tenacity	cN/tex	265	265	310
Density	g cm^{-3}	0.97	0.97	0.97

Extension to break	%	3.5	3.5	2.7
Modulus	GPa	87	120	170
Shrinkage @100C	%	<1		
Tenacity	GPa	2.7	2.7	3.1
Thermal Conductivity @23C	$W\ m^{-1}\ K^{-1}$	20 (axial)		

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